Fake News on Social Media: People Believe What They Want to Believe When it Makes No Sense at All

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Alan R. Dennis
Indiana University Bloomington

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Patricia Moravec, Randall K. Minas and Alan R. Dennis
Kelley School of Business Indiana University

Abstract

Fake news (i.e., misinformation) on social media has sharply increased over the past few years. We conducted an experiment collecting behavioral and EEG data from 83 social media users to understand whether they could detect fake news on social media, and whether the presence of a fake news flag affected their cognition and judgment. We found that the presence of a fake news flag triggered increased cognitive activity and users spent more time considering the headline. However, the flag had no effect on judgments about truth; flagging headlines as false did not influence users' beliefs. A post-hoc analysis shows that confirmation bias is pervasive, with users more likely to believe news headlines that align with their political opinions. Headlines that challenge their opinions receive little cognitive attention (i.e., they are ignored) and users are less likely to believe them.

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> "There is today a special need for propaganda analysis. America is beset by a confusion of conflicting propagandas, a Babel of voices, warnings-charges, counter-charges, assertions, and contradictions assailing us continually through press, radio and newsreel…" (Institute for Propaganda Analysis 1938, p. 1).

> "We are facing nothing less than a crisis in our democracy – based on the systematic manipulation of data to support the relentless targeting of citizens, without their consent, by campaigns of disinformation and messages of hate." (House of Commons 2018)

INTRODUCTION

In the early days of the Internet, people argued that the Internet would enable greater transparency of information, which would increase the quality of democracies (Abramson et al. 1990; Tewksbury 2003). The availability of information from various news sources would enable people to find their own information from non-traditional news outlets, and this decreased reliance on a narrow set of traditional news sources would improve democracy (defined as "the belief in freedom and equality between people, or a system of government based on this belief" (Dictionary 2018)). This vision has been realized with the rise of non-traditional news on social media, but some might argue that the prevalence of fake news on social media has harmed democracy, rather than improved it. An editorial in *Science* calls on the scientific community to help reporters and the general public better identify and avoid fake news (Weiss 2017).

Social media has become a common source for news; more than 50% of American adults read news on social media (Gottfried and Shearer 2016). Social media is different from other media providing news (e.g., TV news, news websites, and mobile phone news apps) because users do not choose the source of all of the articles they see on social media. Instead, proprietary algorithms provide targeted information with little transparency. With other news media, users pick the source first, and do so with a familiarity of the nature of the source (Rice et al. 2018).

With social media such as Facebook, articles from a wide variety of sources appear on users' newsfeeds. News articles are intermixed with sponsored articles (i.e., paid advertisements) and posts from family and friends. All of these may be intentionally or unintentionally true or false, but some are explicitly designed to influence (Shane 2017). For example, Cambridge Analytica developed tools to influence users after it gained access to more than 50 million users' data (Granville 2018). About 23% of social media users report that they have accidently *or intentionally* shared fake news (Barthel et al. 2016). Over 60% say that fake news leaves them confused about what to believe (Barthel et al. 2016).

Social media has moved quality control for detecting fake news from trained journalists to regular users (Kim and Dennis 2018). About 84% of Americans believe that they can detect fake news (Barthel et al. 2016), but how do users detect fake news when most users have no direct knowledge of the facts (i.e., they have not witnessed the events)?

In this study, we examine the effect of a Facebook "fake news" flag and how social media users respond to it. Simply put, we examine the question: are fake news flags effective in altering users' beliefs? We use electroencephalography (EEG) to examine cognitive processes (Dimoka et al. 2012; Vance et al. 2018). We found that flagging articles as fake triggered more cognitive activity, but it did not change users' beliefs in them. We further found that articles that aligned with the user's *a priori* opinions triggered increased cognitive activity, with users more likely to believe them; articles that challenged users' opinions were less thoroughly considered and were less likely to be believed. Our findings triangulate around one explanation: confirmation bias; users believe what matches their prior opinions, undeterred by the actual truth of an article or a fake news flag. As John Mellencamp said in his 2004 song, *Walk Tall*, "People believe what they want to believe/when it makes no sense at all" (Mellencamp 2004).

PRIOR THEORY AND RESEARCH

News has always been questionable in its reliability (McGrath 1986). Even before the rise of the Internet, certain newspapers were known for their biases and potentially distorted news (McGrath 1986). The Internet enables people to access thousands of different news sources, rather than being bound by traditional sources, increasing their exposure to biased and distorted news. The 2016 US presidential election was rife with news, both true and false. Compounding this difficulty, social media users had to contend with the intentional production and distribution of fake news, whether created to generate revenue from advertisements (Kirby 2016) or to influence the election (Fisher 2016; Shane 2017; Sydell 2016). Social media platforms have been criticized for not taking sufficient action to prevent the spread of fake news (Maheshwari 2017).

In the sections below, we examine why assessing the truthfulness of news on social media is difficult, and how flagging fake articles as "disputed by third-party fact-checkers" and confirmation bias may influence users' beliefs. We focus on Facebook as a leader in social media; Facebook has over 2 billion active users and is a popular source for news (Gottfried and Shearer 2016; Statista 2018).

Assessing the Truthfulness of News on Social Media

Context matters (Johns 2006; Johns 2017). "One way to develop richer theories that provide actionable advice is to take the context into greater consideration" (Hong et al. 2014, p.2). Much past IS research has examined work contexts, but our focus is on social media. Most individuals use social media for hedonic purposes (Chauhan and Pillai 2013), such as seeking entertainment or connecting with friends, rather than utilitarian purposes (Johnson and Kaye 2015). Following steps 1-4 in Table 1 of Hong et al., we ground our research in two general theories (confirmation bias and cognitive dissonance) and examine how they influence behavior in this use context. We identified three context-specific factors that make consuming news on social media different from other contexts in which users view information on the Internet.

First, the user's mindset is different, which affects how information is processed. The consumption of news on social media is different than the consumption of information elsewhere on the Internet. For example, it is well known that some product reviews are fake (Dwoskin and Shaban 2018; Dwoskin and Timberg 2018; Roberts 2013). A key difference between fake reviews and fake news is that users do not read product reviews for entertainment; they read reviews for information to make a decision, knowing there is a monetary incentive to make the best, most well-informed decision. Thus, users reading fake reviews are in a utilitarian mindset; their goal is to understand the meaning of the information in the review and to decide which reviews should be considered in making a decision. Minas et al (2014) examined a utilitarian mindset in virtual team interactions in a decision-making context. The study found confirmation bias was present while individuals processed information in a decision-making team-based chat. In contrast, the hedonic mindset when reading social media news means the user's goal is *not* to determine what is true and fake; instead the goal is enjoyment and pleasure. The user will avoid effortful activities that feel like work (e.g., thoughtful information processing) and activities that do not bring enjoyment (e.g., reading stories that your favorite sports team lost). Users engage with articles that make them feel good, which tend to be articles supporting their beliefs.

Second, the source of the information is not clear. With Internet news and traditional news media, we visit the web site of our favorite news network or open our local newspaper; we pick the source before we read articles and do so with some understanding of the source's limitations (Rice et al. 2018). Facebook is different because users do not choose the source of the articles; instead, Facebook's algorithms choose the articles. Although some users subscribe to certain sources by following them on social media, many other sources arrive on our newsfeeds from advertisements, sharing by friends, and algorithmic decisions. Articles from many different sources—some reputable, some disreputable—are intermixed. A fake news article may be presented between a CNN article and Aunt Martha's cookies. The source of the story is obscured (Kim and Dennis 2018), and users in a hedonic mindset are not motivated to invest effort to find and understand the source (Kim and Dennis 2018).

Finally, the sheer volume of fake news makes it challenging to separate truth from fiction. More fake news articles are shared on social media than real news (Silverman 2016). Many fake news sites have appeared on Facebook with the express purpose of spreading carefully-crafted propaganda or to discredit a specific person (BBC 2017). Their low cost and ubiquity is one reason that fake news is common on social media (Barthel et al. 2016).

These three contextual factors—a hedonic mindset, a lack of cognizance of the source, and the volume of fake news—combine to create a context in which social media users do not think as critically as they should when presented with news on social media. More than half the articles shared on Twitter are shared *without* the user reading them, let alone thinking critically about them (Gabielkov et al. 2016). Nonetheless, research shows that there is a bias toward taking an opinion on contentious social media topics, rather than remaining neutral (Jonas 2001). This is true even when users lack information on the topic—or bother to read an article—which helps the spread of fake news (Jonas 2001).

Fact-Checking Fake News

In response to the rise of fake news, fact checking services have become more common. Many solutions have been developed to automate fact-checking. *Truthy* (Ratkiewicz et al. 2011) and *Hoaxy* (Shao et al. 2016) are two such solutions, which can provide relatively quick results for news articles. *Truthy* fact-checks sites that are well-known for verifying the truth of news articles, such as Snopes.com, politifact.com, and factcheck.org, as well as checking known disreputable sites for fake news articles. Fact-checking can influence credibility, especially if done by independent fact-checkers (Wintersieck 2017).

Facebook incorporated fact-checking into its platform and began flagging fake news articles in late 2016 by appending a statement that an article was "disputed by 3rd party fact-checkers" when fact-checkers determined an article was fake (Schaedel 2017). Thus, fact-checking was integrated into the presentation of the article; users did not need to invest effort to seek out a third-party fact-checking site. Facebook discontinued the flag in late 2017 (Meixler 2017). One might conclude that Facebook's actions indicate that fact-checking fake news is not effective. However, the undisclosed reasons why a for-profit corporation makes decisions—especially when its goals are unclear (c.f., Zuckerberg 2016)—are not theoretically compelling.

After Facebook discontinued its fake news flag, third parties began offering their own fake news flagging services that can be integrated into Facebook. For example, NewsGuard provides a browser plugin using source reliability ratings from teams of expert journalists and consultants for more than 4,500 news sites that account for 98% of the online news in the U.S. (NewsGuard 2018). The plugin automatically displays a fake news flag whenever content from a disreputable source is displayed, whether in Facebook or any Web site.

Fact-checking is most important when the user wants to believe a headline; flagging a headline when the user was unlikely to believe it without the flag adds little value. Thus, we focus on the situation where a user is inclined to believe a fake headline, but it is flagged as false.

The Effects of Confirmation Bias

One factor influencing belief is confirmation bias: people prefer information that matches their prior beliefs (Koriat et al. 1980; Minas et al. 2014; Nickerson 1998). Confirmation bias is a bias against information that challenges one's beliefs (Nickerson 1998); it is driven by the fundamental nature of our cognition (Kahneman 2011).

Researchers have long argued that there are two distinctly different cognitive processes, and there are many dual process models of cognition (Evans 2008). Two complementary models emerged in the 1980s. The Heuristic-Systematic Model (HSM) (Chaiken 1980; Chaiken and Eagly 1983) argues that attitudes are formed by the systematic application of considerable cognitive effort to comprehend and evaluate the validity of available information (called the systematic route), or by exerting little cognitive effort using simple heuristics on readily accessible information (called the heuristic route). The Elaboration Likelihood Model (ELM) (Cacioppo et al. 1986; Petty and Cacioppo 1986) argues that attitudes are formed based on deliberate and active consideration of available information to evaluate the true merits of a particular position (called the central route) or as a result of a less cognitively involved assessment of simple positive or negative cues in the context (called the peripheral route).

There are distinctions between HSM and ELM, but they share a common fundamental basis. Both argue that there are two distinct conscious cognitive processes by which attitudes are formed, and that these two processes differ in the amount of cognitive processing expended (e.g., a quantitative difference) and in the cognitive approach used to evaluate information (e.g., a qualitative difference). Both argue that individuals choose which route to invoke based on their ability and motivation to engage in extensive cognition. Both have evolved to argue that the routes are not distinct, so cognition is more of a continuum of processing (Kitchen et al. 2014). ELM is the more popular and is still used today (Cacioppo et al. 2018), although some researchers dispute the notion of dual process models (Melnikoff and Bargh 2018).

Many newer dual process models have been developed (Evans 2008; Evans and Stanovich 2013), because research suggests that many of the fundamental arguments of HSM and ELM (as revised over time in response to criticisms (Kitchen et al. 2014)) are not accurate. For example, the routes are not mutually exclusive (both can be used); the routes are not on a continuum (they are separate); individuals do not choose the route to use (the heuristic route is automatic); individuals cannot avoid the heuristic route (its use is involuntary); and the systematic route cannot operate by itself (the heuristic route always precedes it) (De Neys 2018; Evans 2008; Evans and Stanovich 2013; Kahneman 2011; Pennycook et al. 2018).

In this paper, we adopt the widely accepted dual process model of Stanovich (1999) and Kahneman (2011) who call these separate processes System 1 and System 2. We note that Stanovich has more recently suggested using the terms Type 1 and Type 2 because the use of the word "system" implies there are separate areas in the brain that are dedicated to each type of cognition, which is not the case (Evans and Stanovich 2013).

System 1 runs continuously, and delivers conclusions automatically and involuntarily (Kahneman 2011). Intuition is System 1 at work (Achtziger and Alós-Ferrer 2013; Dennis and Minas 2018). When we receive new information, our System 1 cognition automatically searches long-term memory for confirming evidence and generates a response in less than one second (Bargh and Ferguson 2000; Carlston and Skowronski 1994; Fazio et al. 1986). This process is nonconscious and unavoidable; we cannot prevent it (Evans and Stanovich 2013; Kahneman 2011). It supplies these assessments, even though they are not asked for (Bellini-Leite 2013; Dennis and Minas 2018; Kahneman 2011; Thompson 2013). System 1 is a set of subsystems that run in parallel triggered by different bits of incoming information (Bellini-Leite 2013; Evans 2008; Evans 2014; Thompson 2013). When the different subsystems produce matching results, System 1 produces a “Feeling of Rightness” (FOR) that says it is confident about its conclusions (Bago and De Neys 2017; De Neys 2014; Thompson et al. 2011). When there is conflict among subsystems’ results, FOR creates a sense that something is not right (Bago and De Neys 2017).

In contrast, System 2 cognition is single-threaded (Dennis and Minas 2018) and has much less processing capacity (Evans 2014). System 2 is under our deliberate control, so we can choose to invoke it, but it is easily overwhelmed. System 2 cognition is effortful (Kahneman 2011), and most humans are “cognitive misers” who attempt to minimize cognitive effort (Taylor and Fiske 1978). Thus, we tend to adopt the conclusions of System 1, often without thought (Kahneman 2011). Common triggers causing us to invoke System 2 are a negative stimulus or a surprise (Kahneman 2011), or a FOR that indicates conflicting results (Bago and De Neys 2017).

The net result is confirmation bias (Nickerson 1998). When we see new information, our System 1 automatically, and in less than one second, confirms that it matches our prior knowledge and we are inclined to believe it. Or, our System 1 tells us that it does not match and we should not believe it (Kahneman 2011). Unless we are motivated to expend cognitive effort and invoke System 2, we simply accept the conclusion of System 1 with little thought (Kahneman 2011). And if we were to invoke System 2, how would it help us determine if a news story was true? Unless we have witnessed the events in a story there is no unambiguous way to determine if the story is true or false. Thus, people are likely to accept their System 1 conclusion and believe information that matches pre-existing views (Allcott and Gentzkow 2017).

Confirmation bias also affects the time taken. System 1’s conclusion that new information matches our beliefs is produced in less than a second and simply accepting this takes little time. If our System 1 indicates that we should reject the new information, we are inclined to spend only a little longer before discarding it (Haidt 2012; Kahneman 2011). Minas et al (2014) found that in a utilitarian mindset, all pieces of information are initially considered (by System 1), but the only factual information that matched *a priori* beliefs was selected for System 2 processing. Similarly, Turel and Qahri-Saremi (2016) found that System 1 was linked to impulsive and problematic use of social media and System 2 to more rational and controlled use.

Two aspects of the social media context suggest that social media may exacerbate confirmation bias. First, research suggests that individuals in a hedonic mindset may be less likely to critically consider information than those in a utilitarian mindset, as their consumption is tied to what they desire reality to be, rather than what they know to be real (Hirschman and Holbrook 1982). When in a hedonic mindset we are less likely to expend the cognitive effort to invoke System 2, and more likely to accept System 1's biased conclusions.

Second, social media enables users to choose the news they like and learns their preferences so that it deliberately displays more articles matching their choices. This causes a decreased range of information displayed on a user's newsfeed, so that the news on social media is often biased (The Wall Street Journal 2016). Users' realities on Facebook differ based on what they read and who their friends are (The Wall Street Journal 2016). There are sharp differences in liberal and conservative newsfeeds, with fake news aligned with political beliefs more likely to be seen and shared by users in "echo chambers" of biased information (Bozdag and van den Hoven 2015; Cerf 2016; Colleoni et al. 2014). This bias inundates users with news—real and fake—that supports their views (Bennett and Iyengar 2008; Knobloch-Westerwick and Lavis 2017). Such a stream of biased messages intensifies confirmation bias (Nickerson 1998).

Creating Cognitive Dissonance

One approach to interrupting confirmation bias is to create cognitive dissonance by adding a fake news flag to false stories. Cognitive dissonance occurs when users are presented with two pieces of conflicting information that both cannot be true (Festinger 1962; Mills 1999), which in this case is a fake story users want to believe because it aligns with their *a priori* beliefs and a flag that says it is false. System 1 makes an instant judgement but the conflicting information makes this judgement difficult (Kahneman 2011); the results are unreliable and the FOR tells us something is amiss (Bago and De Neys 2017). This contradiction causes cognitive discomfort (Aronson 1969). The user must decide either to ignore the discomfort or invest effort to resolve it. If the issue is unimportant to them, users typically ignore the cognitive dissonance and accept what their prior beliefs say (Nickerson 1998). Otherwise, they invest effort by invoking System 2 to decide which piece of conflicting information is true (Aronson 1969; Kahneman 2011) which takes more time and requires greater cognitive activity.

When System 2 goes to work to resolve the dissonance, it is influenced, sometimes very strongly, by the unreliable results of System 1 (Kahneman 2011). The System 1 results are stored in working memory and become part of the problem space (Thompson 2013). System 2 has equal access to the information and System 1's unreliable result, and uses both (Thompson 2013). Information is often ambiguous and can be interpreted in different ways (Srull and Wyer 1979). System 2 gives more weight to System 1's result than to the facts that produced it (Srull and Wyer 1980; Srull and Wyer 1983). Thus, an erroneous System 1 result has greater influence on our subsequent System 2 conclusions than the factual information (Dennis and Minas 2018).

In summary, we argue that placing a fake news flag on a story aligned with a user's beliefs will trigger cognitive dissonance. If the dissonance is strong enough, the user will invoke System 2 and expend greater cognitive effort to consider the headline and the fake news flag. The use of System 2 cognition will be indicated by the user taking more time to make a judgment about whether to believe the story or not, and by cognitive activity in certain brain regions. Our study uses the neurophysiological responses measured by EEG as an indicator of cognitive activity. We focus on activity in the frontal cortex because it has been linked with cognitive activity associated with what we commonly consider to be “thinking”: arousal, memory encoding, memory retrieval, insight and consciousness (Başar et al. 1999; Klimesch 2012; Krause et al. 2000; Minas et al. 2017; Pizzagalli 2007). The result of this System 2 cognition is a judgment about the credibility of the story, and we theorize that the fake news flag will reduce credibility. Thus, we have three hypotheses:

H1: Social media users will exhibit increased cognitive activity in the frontal cortex when seeing a fake news flag on a headline aligned with their beliefs.

H2: Social media users will spend more time when seeing a fake news flag on a headline aligned with their beliefs.

H3: Social media users will perceive headlines aligned with their beliefs that are flagged as fake as being less credible.

METHOD

Participants

Eighty-three undergraduates were recruited from a large business core course. All were experienced with social media. Age ranged from 18 to 34 (mean 19.5) and 39% were female. Three reported being left-handed and since a third of left-handed people have differences in brain structure, we removed all three participants from our EEG analyses.

Task

Participants read 50 fact-based news headlines and assessed their credibility. The headlines covered 10 topics related to US politics and were actually true or false. Forty headlines were designed to be possibly true or false, though verifiably one or the other (e.g., Trump defunds Planned Parenthood, minimum wage should be $21.72 to keep pace with inflation). Ten headlines were controls intended to be more clearly true (e.g. Trump launches Twitter tirade;

Hollywood celebrities oppose Trump). See Appendix A for headlines. Participants spent an average of 10.5 seconds reading each headline before beginning to answer questions about it.

Treatment

The experiment mimicked the Facebook display, although participants were not able to like, comment, or share the story. A flag matching Facebook's fake news flag was randomly assigned to 20 of the 40 non-control headlines (including those actually true) (see Figure 1).

Measures

The primary behavioral dependent variable was the credibility of the headline, measured using three 7-point items from Beltramini (Beltramini 1988): believability, credibility, and truthfulness. The Cronbach alpha was 0.94, indicating adequate reliability.

The second behavioral dependent variable was the time participants took to form their credibility assessment. The time was measured from the initial display of the headline until the participant clicked a button to display the credibility questions.

The alignment of a headline with the participant's political beliefs was coded as a binary variable; headlines positively supporting the participant's beliefs were coded as a 1; headlines that did not were coded as 0. We used ten sources of self-reported data to assess the extent to which a headline aligned with participants' political beliefs. The participants reported their political affiliation on a 4-point scale (Democrat, Independent leaning Democrat, Independent leaning Republican, and Republication), which was collapsed into either Democrat (first two responses) or Republican (second two responses). They reported who they would vote for (Clinton or Trump) if the 2016 presidential election was held today. The election had been held four to six months prior. They also answered eight items (7-point scale, with 4 as neutral) measuring their political conservatism (Everett 2013) across topics related to the headlines. Our sample was fairly balanced politically, with 47% being self-reported Republicans and 53% Democrats; 31% reported that they would vote for Trump at the time of the study. See Appendix B for more information.

Two raters independently matched the headlines to the single most closely matching item out of the ten political belief items and agreed on 46 of the 50 headlines (92%); differences were resolved. For example, an anti-abortion headline was matched to the anti-abortion item (with those scoring 5-7 being susceptible to confirmation bias). A gun-rights headline was matched to the gun-rights item. A Trump-supporting headline was matched to a Trump voter.

Changes in cognition were measured using time-frequency analysis of EEG data. EEG is a neurophysiological tool that enables the examination of neurophysiological changes that occur during information processing on the order of milliseconds (Berger 1929). EEG measures small electrical signals produced in the superficial areas of the underlying cortical regions. These electrical signals form complex wave patterns at specific frequencies that are related to cognitive activity. Berger's early research showed the importance of the alpha wave (originally called "Berger waves"), and its potential to indicate specific mental processes, including arousal, memory and consciousness (Pizzagalli 2007).

A 2012 review concluded that alpha-band waves (8-13Hz) indicate brain activity across many brain regions (Klimesch 2012). Alpha waves have been shown to change reliably in response to stimuli (Klimesch 2012). When a region of the brain becomes active, alpha waves desynchronize, leading to lower alpha levels (Cohen 1995); thus alpha wave desynchronization indicates higher levels of cognitive activity (Kelly et al. 2006; Klimesch 2012; Makeig et al. 2002). The upper alpha frequency band (~10-13Hz) shows encoding memory processes in the parietal and frontal cortex regions (Kilner et al. 2005; Klimesch et al. 1997; Klimesch et al.

2001; Klimesch et al. 1996; Moretti et al. 2013).

We use time-frequency analysis, event-related spectral perturbation (ERSP), to analyze event-related desynchronization (ERD) (Makeig 1993). It is important to note that, despite the similar acronym, time-frequency analysis (e.g., ERSP) differs from traditional event-related potential (i.e., ERP) studies in that it examines a frequency band (e.g., alpha wave) over a specified time-period. Event-related potentials, common in cognitive neuroscience studies, examine specific waveforms that occur at a specified time period (e.g., P300 is a positive spike in neural activity that occurs at 300 milliseconds in response to rare events). In time-frequency analysis, we look for a pattern of changes (i.e., spectral changes) over a period of several seconds. We analyzed the last 4 seconds the participant viewed the headline to account for the time participants read the headlines. The alpha frequency band was examined for significant alpha ERD in the 10 to 13Hz frequency band as has been suggested and done in prior research (Minas et al. 2014; Müller-Putz et al. 2015). See Appendix C for more details.

We used a 14-channel Emotiv wireless EEG device (see Figure 2). There is a concern that wireless data collection may suffer from dropped packets due to interference. The data includes a variable indicating if any signal loss occurred during data collection and marking packets that were interpolated. We removed all artifacts and interpolated data. There has been debate within the cognitive neuroscience community about the validity of low-cost EEG systems like Emotiv. Many studies have scrutinized the Emotiv device in a variety of settings such as, examining working memory (Wang et al. 2015), auditory analysis (Badcock et al. 2013), mobile brain-computer interfaces (Debener et al. 2012), detection of the P300 wave (Ramírez-Cortes et al. 2010; Wang et al. 2015), human-computer interaction (Taylor and Schmidt 2012), and hemispheric asymmetry (Friedman et al. 2015). These studies have found Emotiv to obtain a reliable and valid signal of underlying cortical activity as good as larger high-density systems albeit with lower spatial resolution so that the edges of regions are not as sharp and clear.

RESULTS

Behavioral Results

We used Hierarchical Linear Modeling (HLM) to analyze the credibility and time data; see Table 1. Confirmation bias is present, with participants more likely to believe headlines to be credible when they aligned with the user's political beliefs ($t(4150)=2.46$, $p=0.014$). The fake news flag (Flagged as False) had no effect ($t(4150)=0.52$, $p=0.601$). Surprisingly, participants were more likely to believe that true headlines were *less* credible ($t(4150)=2.45$, $p=.014$). We note that participants had difficulty assessing whether headlines were true or false; they correctly assessed only 44%. Participants spent 1.4 seconds longer considering a headline when the headline was flagged as false ($t(4150)=3.32$, $p=0.001$), and an additional 1.9 seconds when the headline was flagged as false and the headline aligned with their beliefs ($t(4150)=2.45$, $p=0.014$).

These results support H2 (that users take more time when seeing a fake flag on a headline aligned with their beliefs). However, H3 was not supported: the fake news flag did not reduce the credibility of headlines aligned with beliefs.

Neurophysiological Results

We examined the cognition triggered by a headline that supported the participant's beliefs but was flagged as being false. When a brain region is active, desynchronization of neural activity in the alpha band occurs (called "alpha blocking") (Potter and Bolls 2012), thus event-related desynchronization (ERD) is an indicator of cognitive activity. Event-related spectral perturbation analysis produces a set of areas within the brain (called clusters) showing the location of ERD and whether there are significant differences between the treatments. With this analysis, the researcher does not specify which superficial layers of cortex to test (all regions are tested), which is a major strength of this approach; it is not limited to *a priori* decisions which may or may not fit the reality of participant cognition. The clusters identified by the analysis may or may not align with the regions that the researcher has hypothesized about, and may span several distinct brain regions, making interpretation challenging. However, when a cluster includes a theorized region, it is a powerful signal supporting the theory, because nothing in the analysis directed the software to consider the theorized region; the region emerged from the data.

The challenge occurs when a cluster shows significant differences between treatments in regions the researcher did not theorize prior to the analysis. In this case, the researcher must interpret what cognitive activity in those region(s) means. Unfortunately, there are often several ways to interpret activity as each brain region is responsible for a complex set of disparate activities (Poldrack 2011). This has been called the reverse inference problem (Poldrack 2011).

For researchers grounded in quantitative positivist traditions, the reverse inference problem is intractable (Fischer 1970) because it is usually impossible to apply deductive reasoning to unequivocally produce a result (Fischer 1970). For researchers grounded in qualitative interpretivist methods, reverse inference is normal science using abductive reasoning (Dubois and Gadde 2002; Peirce 1931-1958). Abduction is a form of scientific reasoning that starts with data and sorts through the possible explanations to find the most appropriate explanation (Dubois and Gadde 2002; Peirce 1931-1958). Quantitative researchers routinely use abduction to build theory (Van de Ven 2007), so the question is not whether to use abduction, but rather when to use it – before or after data collection, or both.

We strongly advocate for reverse inference using abduction after data collection when the analysis shows significant differences in regions that were not theorized prior to data collection.

After all, what is the alternative? Ignore significant effects that were not theorized? Ignoring the unexpected is not good science. For us, reverse inference is not a problem; it is an opportunity for discovering the unanticipated. Care must be taken in experimental design to eliminate as many competing explanations as possible, and when interpreting unexpected results, we must use abductive reasoning to determine the most likely explanation (Poldrack 2011). Subsequent research can then theorize and test the newly discovered unexpected results for generalizability.

Our analysis produced two neurological clusters with significant differences that suggest participants experienced cognitive dissonance. The first cluster was as hypothesized in frontal cortices (see Figure 3). Participants showed significantly more ERD in the frontal cortices for headlines that supported their beliefs but were flagged as false. The differences are across the upper alpha band and are spread throughout the time period. Increased ERD in the frontal cortices is associated with increased cognitive activity, including arousal, memory, and consciousness (Pizzagalli 2007) and arousal, memory access, and consciousness (Başar et al. 1999; Krause et al. 2000; Pizzagalli 2007). The frontal cortices are active during deliberate cognitive tasks and high-order cognitive processes (Başar et al. 1999; Kilner et al. 2005; Klimesch et al. 1997; Klimesch et al. 2001; Klimesch et al. 1996; Krause et al. 2000; Moretti et al. 2013). This indicates that participants spent more cognitive activity considering headlines that supported their beliefs but were flagged as false than other headlines.

The second cluster also shows ERD in the frontal cortices, but also includes some unexpected activity in the right parietal region (Figure 4). Activity in the right parietal can indicate encoding and retrieving a stimulus in working memory (Foxe and Snyder 2011; Gevins et al. 1997; Mevorach et al. 2006). Increased ERD in the right parietal cortex is indicative of directing attention toward salient stimuli (Foxe and Snyder 2011; Mevorach et al. 2006), and turning toward a stimulus (rather than away) (Schutter et al. 2001). It has also been linked to sustained attention to a stimulus being retained in working memory and encoding or retrieval of semantic memory (Gevins et al. 1997; Klimesch et al. 1997; Klimesch et al. 2001). Both interpretations provide a similar conclusion: individuals paid more attention to headlines supporting their beliefs that were flagged as false.

Taken together, these two clusters indicate that subjects spent more cognitive effort considering a headline that supported their beliefs but was flagged as false compared to other headlines (e.g., those supporting their beliefs but not flagged, or challenging their beliefs (flagged or not)). This increased cognitive activity also corresponds to the increased time that subjects spent on these headlines (Table 1). H3 is supported.

Post hoc Analysis on Confirmation Bias

We also conducted a post hoc analysis investigating cognition in the presence of confirmation bias, because past research in a different context (virtual team decision making – a utilitarian mindset) has found that individuals are more likely to engage in cognitive activity when they encounter information that supports their opinions and simply ignore information that opposes their opinions (Minas et al. 2014). The context in this study is different because social media users are in a hedonic rather than a utilitarian mindset (Chauhan and Pillai 2013). Hedonic and utilitarian motivation have been shown to have differential effects on confirmation bias (Borrero and Henao 2017; Stone and Wood 2018).

This post hoc analysis found increased cognitive activity in two clusters when participants saw headlines aligned with their opinions (i.e., when confirmation bias was present): the frontal cortices (Figure 5a); and the right parietal and somatosensory region (Figure 5b). As noted above, increased activity in the frontal cortices is linked to increased higher order cognitive processes, while increased activity in the right parietal is linked to focusing attention. Increased ERD in the somatosensory region has been linked to motion, planning for motion, or tactile sensations (Hari et al. 1998; Porro et al. 1996), which is hard to interpret in this situation. We conclude that once participants realized that a headline supported their political opinions, they directed their cognitive attention to the headline, but when they realized that a headline challenged their opinions, they did not direct attention to it.

DISCUSSION

Our study examined whether a fake news flag helped social media users discern true news from fake news. Our results show that the fake news flag did not influence user beliefs, although it triggered more cognition and increased the time spent considering the headline. Instead, users were more likely to believe news headlines they wanted to be true. Table 2 summarizes the results.

The EEG results show two interesting findings. First, in the absence of a fake news flag, significantly more event-related alpha desynchronization was observed in the frontal cortices and the right parietal for headlines that supported the participant's beliefs. In other words, once participants recognized that a headline supported their beliefs, they devoted attention to it; once they recognized that a headline opposed their beliefs, they did not process it further.

Second, when participants viewed headlines that supported their beliefs but were flagged as fake, cognitive dissonance occurred. The EEG results showed activation in the frontal cortices and right parietal, which suggests that participants engaged in additional cognition to resolve the cognitive dissonance. However, this additional cognition only resulted in users deciding to disregard the fake news flag and believe the fake news article.

We see three key conclusions in our results. First, the presence of a fake news flag did not affect how participants perceived the credibility of the headlines. The time and EEG results indicate that the flag caused cognitive dissonance and induced participants to think more deeply about the truth of the headline. However, the cognitive dissonance triggered by the flag was not enough to overcome participants' inherent confirmation bias; although they thought more, this additional thought did not cause them to believe the headline less. The flag was simply not strong enough to make users overcome their *a priori* beliefs. Perhaps in the era of fake news, users are more likely to dismiss information that challenges their opinions as being fake. This fake news flag is an ineffective remedy for fake news; again, we note that Facebook discontinued its use in 2017 (Meixler 2017).

Second, confirmation bias drives beliefs. Participants were more likely to believe and process headlines that aligned with their beliefs. This likely did not result from additional knowledge; participants were not correct in their perceptions of truth. Rather, participants likely found these topics more credible because any attempt to believe that the headlines were false would result in cognitive dissonance. Rather than expend cognitive effort to consider the actual truth of the article, participants rejected reality in favor of their *a priori* beliefs (Allcott and Gentzkow 2017; Koriat et al. 1980; McKenzie 2006; Nickerson 1998). We confirm that social media is highly subject to confirmation bias.

Third, the real underlying truth of the headlines had little effect on whether participants believed the headlines or not. Participants were not more likely to believe headlines that were verifiably true. It may be that an increased awareness of fake news may have caused participants to be naturally more skeptical of all headlines presented; the mean credibility score of 3.7 across all headlines suggests a slight bias towards skepticism.

Limitations

We began by theorizing that the context of social media is important; social media use is often hedonic as users browse on cell phones while waiting in line, on laptops while watching TV, and so on. Yet we studied use in the cold, clinical context of a lab experiment, where we could carefully control exogenous factors. Ecological validity was challenged, as participants were wearing an Emotiv headset, the headlines were displayed on separate pages instead of a scrolling homepage, and participants were not on their own social media pages. This setting may have triggered a utilitarian mindset of thinking more deliberately about the headlines than the normal everyday setting of social media use, perhaps weakening the effects we found. Thus, the effects observed in the lab may be understated; the real problem may be worse. We note that other studies using neurophysiological data have the same limitations (Vance et al. 2018).

Our study also suffers from the other usual limitations of laboratory studies. Participants were undergraduate students, which may not be representative of the population as a whole (Koriat et al. 1980). They had experience with social media, but care should be taken when generalizing to populations that may not have as much experience. The neuroanatomy of some young adults changes through their teens into their mid-20s, with neuroplasticity (i.e., changes to neural structures and networks) also prevalent in adulthood (Draganski et al. 2004; Sowell et al. 1999). However, we are unaware of any studies that show systematic differences in alpha attenuation between young adults and adults decades older.

Additional limitations come from the context of fake news itself. This context is continually changing, as concerns about fake news wax and wane, types of misinformation change and online social media platforms are revised in response.

Implications for Research

First and foremost, our research shows that the fake news flag triggered more cognitive activity and caused users to spend more time when the flag was placed on headlines they wanted to believe. However, it did not change the result of that cognition. At one level, this indicates that fact-checking may have promise (because it did trigger deeper cognition to resolve cognitive dissonance). But it may be optimistic to believe that a simple "disputed" flag might trigger the deep introspection needed to overcome confirmation bias and resolve cognitive dissonance. Future research needs to develop and test a stronger signaling mechanism for the results of fact-checking, one that might be strong enough to overcome confirmation bias. Perhaps this could be a different flag with stronger words, or a different type of intervention altogether.

Second, the post-hoc analysis indicates that future research needs to understand how we can overcome confirmation bias in the use of social media. Our results show that once users recognize that a headline challenges their *a priori* beliefs, they stopped thinking about it. In other words, confirmation bias is so strong in social media use that users simply stop thinking about information they don't like. We need more research on confirmation bias in social media use.

Third, we used EEG to complement other sources of data such as self-reported data (i.e., beliefs in the headlines) and observed data (i.e., time taken), as has been advocated in the use of neurophysiological tools in IS research (Dimoka et al. 2012). The primary advantages of neurophysiological data are that they are generally not susceptible to subjectivity bias, social desirability bias, and demand effects (Dimoka et al. 2012). The use of three distinct types of data enabled us to triangulate across the different sources to better understand the phenomenon (Dimoka et al. 2012). We encourage future research to consider using neurophysiological data.

Finally, our results add to the growing list of evidence that fake news is becoming a major societal problem (House of Commons 2018; Weiss 2017). Many solutions have been proposed, and many pundits have offered opinions. However, we have little empirical research on the effectiveness (or lack thereof) of the many proffered options. We need more research on ways to improve social media users' ability to discern truth from fiction, and more research on ways to induce social media users to invest more time and attention in the news they see and to restrain from spreading fake news without reading it (Gabielkov et al. 2016).

Implications for Practice

Facebook's fake news flag had no effect on beliefs. It did not induce participants to conclude that a news article was less credible. They spent more time when a headline they supported was flagged as fake, but the flag did not change their beliefs. Perhaps more importantly, the actual truth of a headline did not influence users' beliefs; users were generally unable to accurately separate true news from fake news. We conclude that we need to develop a better method for warning social media users of fake news.

People will continue to consume news on social media and will continue to struggle to determine its truthfulness. The sheer volume of fake news on social media (Silverman 2016) means that this problem is unlike any we have seen before; "quantity has a quality all its own." (attributed to Josef Stalin). There are real and demonstrable consequences from enabling the spread of posts that are verifiably false in order to spread disinformation or profit from users' gullibility (House of Commons 2018). We believe that Facebook and other social media firms have a responsibility to better enable their users to discern truth from fiction (see House of Commons 2018).

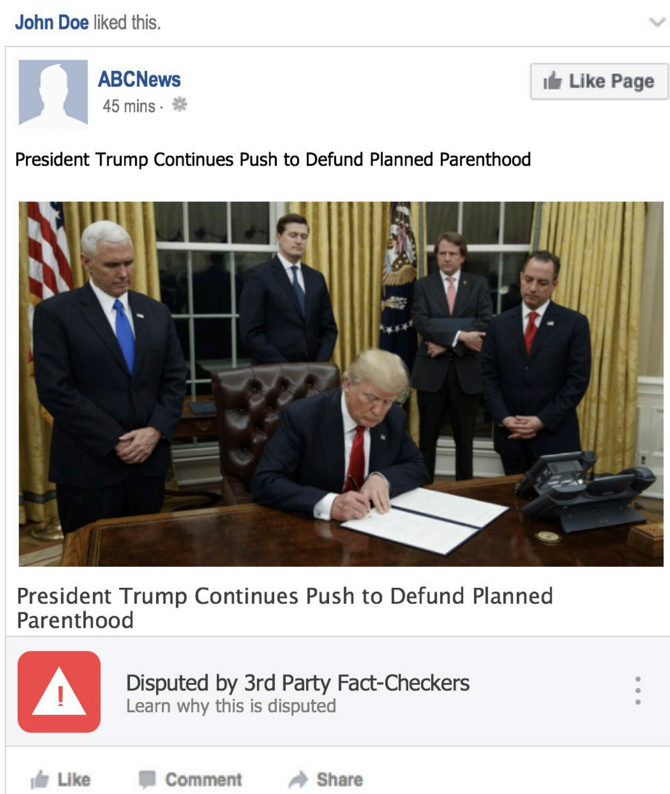


Figure 1: Fake News Flag on a Facebook Headline

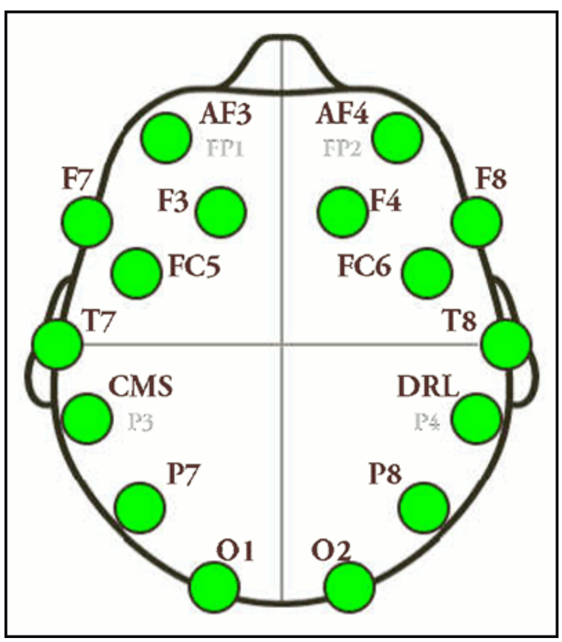


Figure 2. Position of the electrodes on the EEG headset with labels along the 10-20 system.

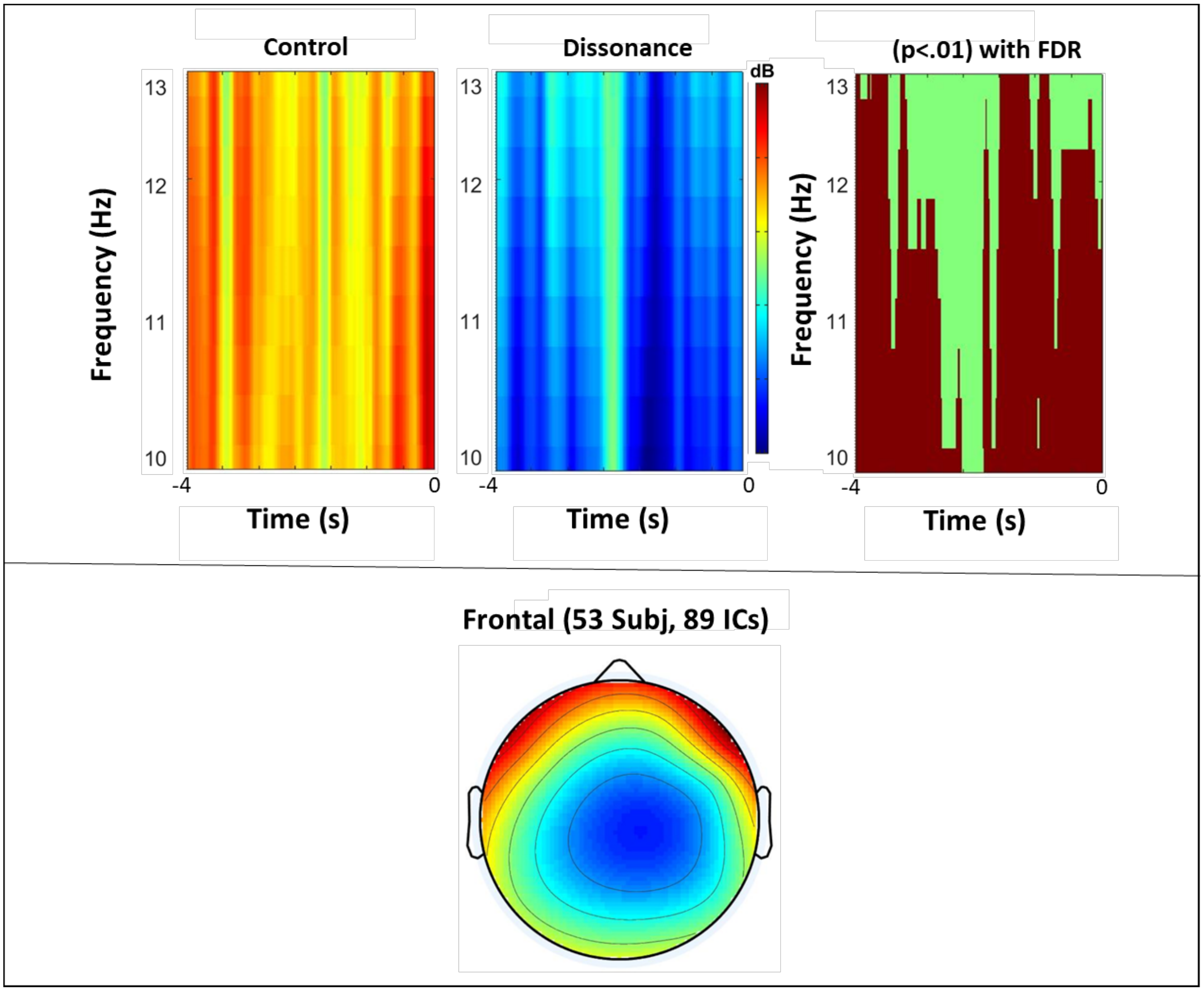


Figure 3 Differences in Frontal Cortices Cluster due to Cognitive Dissonance

The top left and middle panel shows alpha activation for headlines we theorize create dissonance (one that support the participant's beliefs and were flagged as false (middle panel) versus all other headlines (left panel); cooler colors (i.e., blue) indicates greater cognition (i.e., greater event-related desynchronization). The right panel shows significant differences (in red) between the two panels, at p = .01 with a false discovery rate correction for multiple comparisons. In the scalp map, red indicates the regions identified as being active (i.e., contributing the most variance) in the cluster.

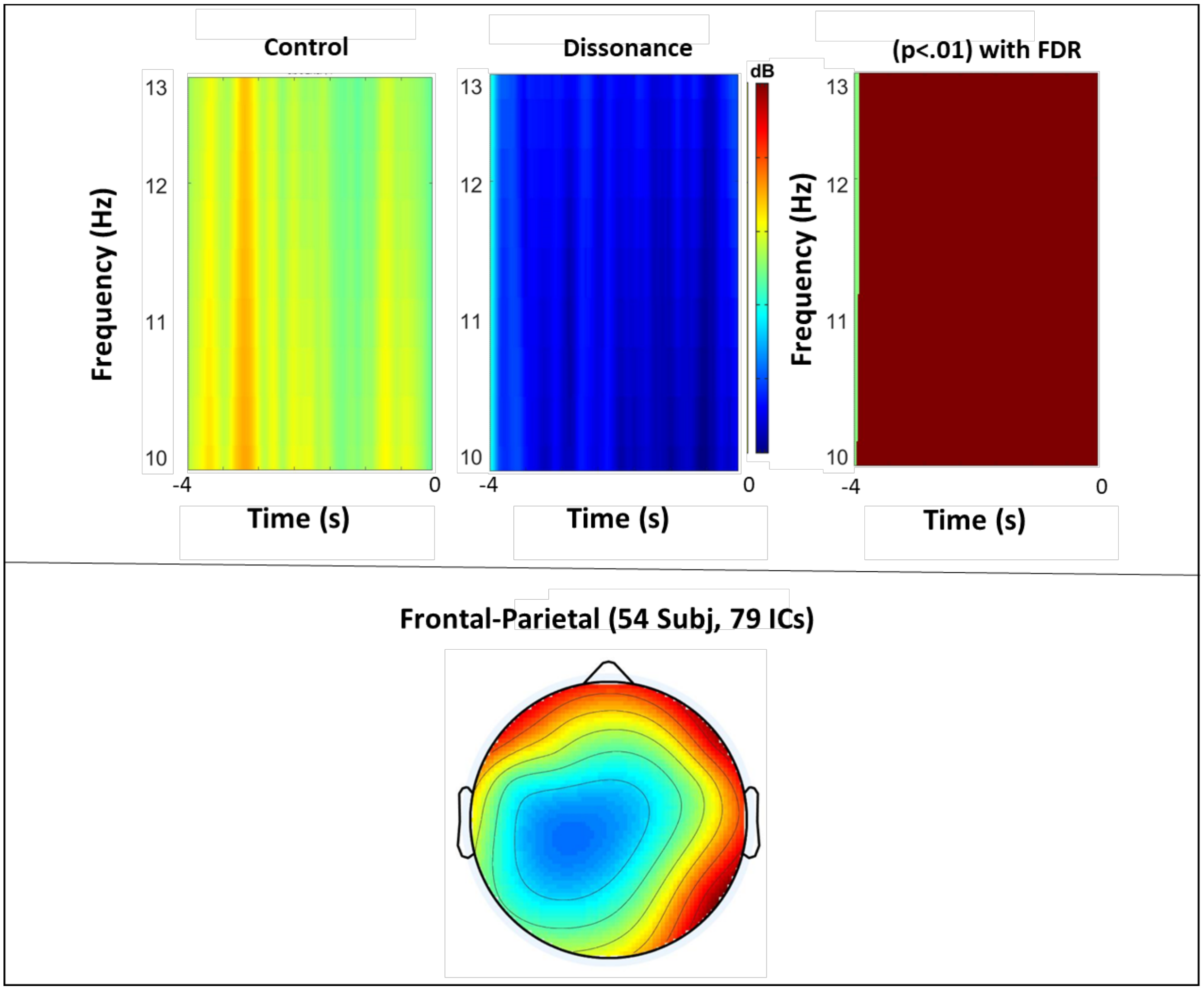
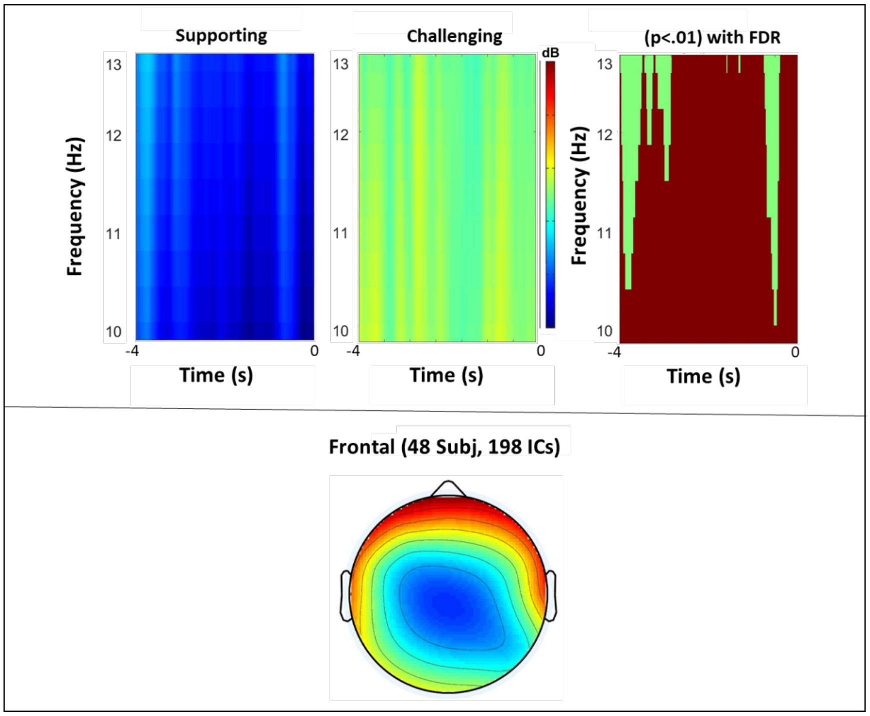
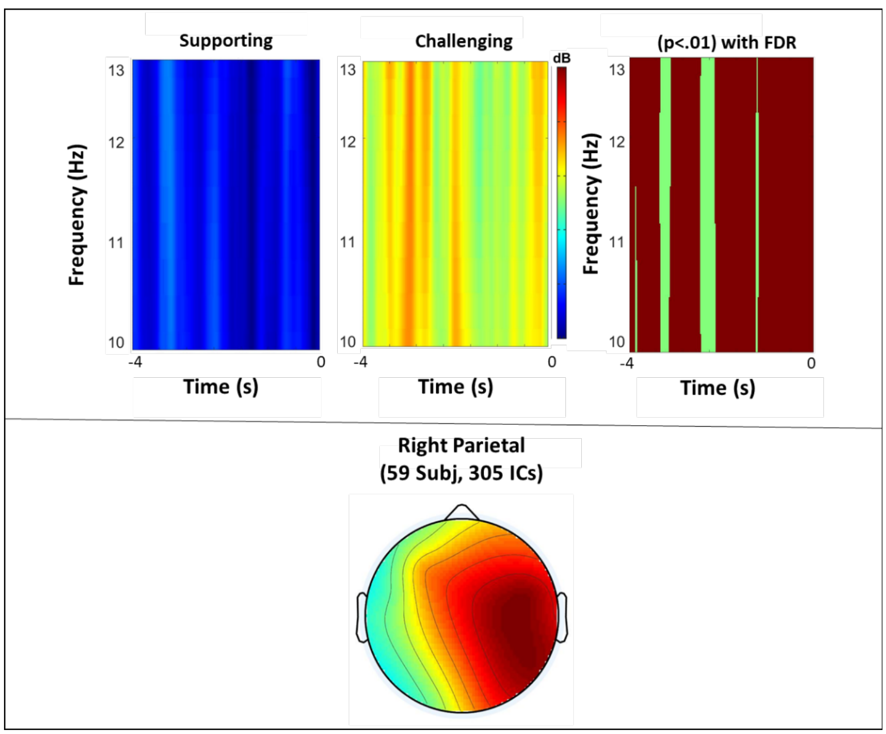


Figure 4. Differences in Frontal and Right Parietal Cluster due to Cognitive Dissonance
This analysis shows cognition for headlines that supported a participant's political beliefs and were flagged as false (middle panel) versus all other headlines (left panel); blue indicates greater desynchronization. The right panel shows significant differences (in red) between the two panels, at p = .01 with a false discovery rate correction.



a) Frontal cortices



b) Right parietal and somatosensory

Figure 5: Differences due to Confirmation Bias

Headlines supporting the participant's beliefs trigger greater cognitive activity in the frontal cortices (Panel a) and in the right parietal and somatosensory regions (Panel b).

Table 1: Behavioral Outcomes

Factor	Perceived Credibility Coefficient	Perceived Credibility P-value	Time Spent in Seconds Coefficient	Time Spent in Seconds P-value
Intercept	3.328***	0.000	8.166	0.062
Political Party (Democrat=1)	0.312*	0.016	-0.913	0.248
Gender	0.053	0.689	0.169	0.836
Age	0.012	0.738	0.116	0.598
Aligned with Beliefs	0.177*	0.014	-0.637	0.179
Actually True	-0.130*	0.014	-0.064	0.855
Flagged as False	0.033	0.601	1.364***	0.001
Flagged X Aligned with Beliefs	-0.035	0.762	1.884*	0.014

Note: * p<.05, ** p<.01, *** p<.001

Table 2: Summary of Results

Hypothesis	Description	Supported
H1	Social media users will exhibit increased cognitive activity in the frontal cortex when seeing a fake news flag on a headline aligned with their beliefs.	**Yes**
H2	Social media users will spend more time when seeing a fake news flag on a headline aligned with their beliefs.	**Yes**
H3	Social media users will perceive headlines aligned with their beliefs that are flagged as fake as being less credible.	**No**

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